COMPARATIVE ANALYSIS ON POWER QUALITY ASSESSMENT OF WIND ENERGY AND SOLAR ENERGY WITH INNOVATIVE DEVICE

A
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1 INTRODUCTION

There has been a global trend towards the utilization of green or renewable energy, which owes much to the rapid consumption of non-renewable power resources. Approximately 1.4 billion people around the world are still disconnected from a basic supply of electricity and it is generally agreed that renewable energy is one of the most viable solutions pertaining to this issue[1, 2]. Renewable energy is generally derived from either solar, wind, hydro, geothermal or biomass. Upon generation, the green energy will then be distributed to the end-users via the main power grid or standalone distributed generators that are connected to the main grid. However, because the investment involved in producing renewable energy is high [3], the level of penetration of such energy market is still relatively low. The application of green energy is still confined in cities where are concentrated on the developments and funds. Furthermore, there have been applications of remote renewable energy technologies such as solar photovoltaic (PV) systems, micro-hydroelectric systems, wind-hybrid systems as well as biomass gasification systems in rural areas in several countries in Latin America, Africa and South and Southeast Asia[4-6]. The off-grid electrification method is advantageous, especially when the grid extension is not economically or environmentally viable [7-9]. On the other hand, after the establishment of these green energy technologies, the main issue of concern is the reliability, which is characterized as the power quality of the supplied energy. The efficiency of green power generators must be higher than continuation sources due to the irregularities of green energy sources such as solar and wind. These issues must first be overcome before penetration of green energy can be enhanced. The following FACTS devices were combined and made available: Static Var Compensator (SVC); Thyristor Controlled Series Compensator (TCSC); Dynamic Flow Controller (DFC); HVDC Back to Back (HVDC B2B); Static Synchronous Compensator (STATCOM); Static Synchronous Series Compensator (SSSC); Unified Power Flow Controller (UPFC); and Dynamic Power Flow Controller (DPFC), MPPT for Solar system.

These were designed to perform the some tasks such as power flow control, voltage adjustment, reactive power compensation, transient and voltage satiability improvement, transmission capability enhancement, power conditioning, power quality improvement and

interconnection of renewable and distributed generation and storages [10]. The impacts of FACTS devices occurred by switching or controlled shunt compensation, series compensation or phase shift control. These devices work electrically as fast current, voltage or impedance controllers. An example of FACTS for shunt compensation is shown in Fig 1. The power electronics allow for very short reaction times down to far below one second. FACTS device is used for long distance AC transmission lines and the AC system performance [11], [12]. Moreover, FACTS can be in interconnected power systems' technical problems solving.

Solar cells converts solar energy into electrical energy, these photovoltaic cells are essentially electronic devices. Photo voltaic cells do not have the capability of storage capability, but this storage can be provided using batteries. These Photovoltaic(PV) cells converts most abundant and freely available solar energy into electrical energy without causing any harm to the environment, where as in the case of thermal plants produces harmful gasses into the atmosphere. PV cells produce electricity without having any mechanical rotating part, thereby the losses with this type of generation are very less. The voltage generated by this solar cells is analogous to that of battery. The voltage and current ratings of the solar cell can be increased by connecting positive and negative leads of cell in series and parallel combination. PV panel is a combination of PV cells in series and parallel connection, the PV module is acombination of some PV panels. Commercial and industrial solar power system installation string voltages may vary from 300-1000 V and currents of the range 5-10 A.

1.1 Wind Energy System

Wind may be abundant very nearly in any and only the universe. Its presence for nature brought on by uneven warming on the surface of the earth and also the earth's revolution implies that the wind assets will generally a chance to be accessible. Wind vitality will be nothing yet the speed Eventually Tom's perusing which those air streams. It is about dynamic energy; presently times we would utilizing wind plants with produce electrical force. A windmill may be An machine which changes over the vitality about wind under rotational vitality Eventually Tom's perusing method for vanes known as cruises or blades. Initially windmills were formed to processing grain for nourishment creation. In the span …of historical backdrop the windmill might have been adjusted will huge numbers other mechanical utilization. A paramount requisition might have been on pump water. Windmills utilized for generating power would ordinarily known as wind turbines. The customary routes

of generating power utilizing non renewable assets for example, coal, common gas, oil thus on, need incredible effects on the nature's domain as it contributes limitless amounts from claiming carbon dioxide of the earth's air which thus will foundation those temperature of the earth's surface will increase, known as the green house impact. Hence, with those progresses for science and technology, routes of generating power utilizing renewable vitality assets for example, such that the wind need aid created. Nowadays, the expense from claiming wind energy that is associated with those grid may be as Shabby Concerning illustration those cosset of generating power utilizing coal Furthermore oil. Thus, the expanding Notoriety of green power implies the interest for power prepared Toward utilizing non renewable vitality may be likewise expanded Appropriately.

1.2 Features of Wind Power Systems

There are a few dissimilar vitality end use features from claiming wind control frameworks.

I. The greater part wind energy destinations need aid to remote rural, island alternately marine territories. Vitality prerequisites clinched alongside such spots need aid dissimilar and don't require the helter skelter electrical force.
II. A control framework for blended personal satisfaction supplies could make a great match with downright vitality wind utilize i. E. The supply about Shabby variable voltage energy to warming and unreasonable settled voltage power to lights Also motors.
III. Provincial grid frameworks are inclined with a chance to be powerless (low voltage 33 KV). Interfacing a Wind vitality change framework (WECS) Previously, feeble grids may be was troublesome Also impeding of the workers' safety.
IV. There need aid generally periods without wind. Thus, WECS must a chance to be connected vitality stockpiling or parallel generating framework whether supplies would should make upheld.

1.3 Power from the Wind

Dynamic vitality from the wind may be used to transform those generator inside those wind turbine to handled power. There need aid a few variables that help the effectiveness of the wind turbine for extracting those energy from the wind. Firstly, the wind pace may be a standout amongst the vital elements over deciding what amount of control could a chance to be concentrated from those wind. This may be in light the control prepared starting with those wind turbine will be An capacity of the cubed of the wind speed. Thus, those wind speed On

doubled, those control generated all the will be expanded Toward eight times the first force. Then, area of the wind ranch assumes a paramount part with the end goal the wind turbine on extricate those the vast majority accessible control type the wind.

Those following paramount element of the wind turbine will be those rotor edge. Those rotor blades length of the wind turbine is a standout amongst those imperative parts of the wind turbine since the force prepared from the wind will be also proportional of the cleared territory of the rotor blades i. E. The square of the breadth of the cleared zone.

Hence, by multiplying the breadth of the cleared area, those force prepared will a chance to be four fold expanded. It is obliged to the rotor blades on be solid Also light tough. Concerning illustration the sharpened steel period increases, these qualities of the rotor blades ended up additional subtle. However for the late progresses done fiberglass Furthermore carbon-fiber technology, those creation of lightweight solid rotor blades between 20 should 30 meters in length will be workable. Wind turbines for the extent about these rotor blades need aid fit to process dependent upon 1 megawatt of energy.

The association the middle of the control transformed Toward the wind sourball and the speed of the wind and the rotor blades cleared breadth is demonstrated The following.

$$P_{wind} = \frac{\pi}{8} dD^2 v_{wind}^3$$

Those inference should this equation could make gazed dependent upon done [2]. It if make noted that a few books determined those equation As far as the cleared range of the rotor blades (A) and the air thickness will be indicated as.

Thus, to selecting wind turbine accessible in the market, those best also effective wind turbine will be the particular case that could aggravate the best utilization of the accessible dynamic vitality of the wind.

Wind energy need those Emulating preferences In those conventional control plants.

- Enhancing cost competitiveness,.
- Secluded installation,.
- Fast construction,.
- Reciprocal generation,.
- Moved forward framework reliability, and.
- Non-polluting.

1.4 Wind Turbines

There need aid two sorts about wind turbine over connection to their rotor settings. They are:.

- Horizontal-axis rotors, What's more.
- Vertical-axis rotors.

In this report, just those horizontal-axis wind turbine will make talked about since those demonstrating of the wind driven electric generator may be accepted will bring those horizontal-axis rotor.

Those horizontal-axis wind turbine is outlined thereabouts that the blades turn in front of the tower for admiration to those wind heading i. E. Those pivot of revolution are parallel of the wind course. These need aid by and large alluded will Concerning illustration upwind rotors. An alternate sort about level hub wind turbine will be known as downwind rotors which need blades pivoting in back of the tower. Nowadays, just those upwind rotors would utilized within vast scale energy era Furthermore in this report, those expression. Horizontal-axis wind turbine alludes of the upwind rotor plan.

1.5 Motivation

The demand for the electrical energy increasing every day, and the availability of fossil fuel sources declining day by day, this made me to think about alternative energy source solar energy. A lot of research is being going on this area, but still the effective utilization of solar energy is not happening. This thing motivates me to work on extract maximum power from the solar cell, and to connect the solar cell effectively to the grid, and to contribute my way of thoughts towards thepower quality improvement of the system, when a solar cell is connected to the grid.

1.6 Proposed Methodology and Architecture

1.6.1 Introduction

The control of active power and reactive power exchange between grid connected converters and the utility grid is an important factor when considering the operation of ac power systems that employ distributed generation. The call for a sustainable society with renewable and distributed resources has driven the implementation of power electronic technology into ac power systems. Recently a power electronic converter called the static VAr compensator (STATCOM) has been employed to provide reactive power support to the ac power system. Active power support cannot be provided with the standard STATCOM due to the limited energy stored in the dc-link capacitor, nonetheless the

real power capabilities of the STATCOM can beenhanced by the addition of energy storage to the dc-link. The exchange of active power and reactive power can be controlled by adjusting the amplitude and phase of the converter output voltage.

1.7 Objectives

- To study about the renewable energy.
- To work for power quality improvement
- Simulation on photovoltaic cell and wind energy model
- Power quality improvement using reactive power compensation
- To enhance the power quality of wind and solar system using innovative devices like FACTS.

1.8 Problem Statement

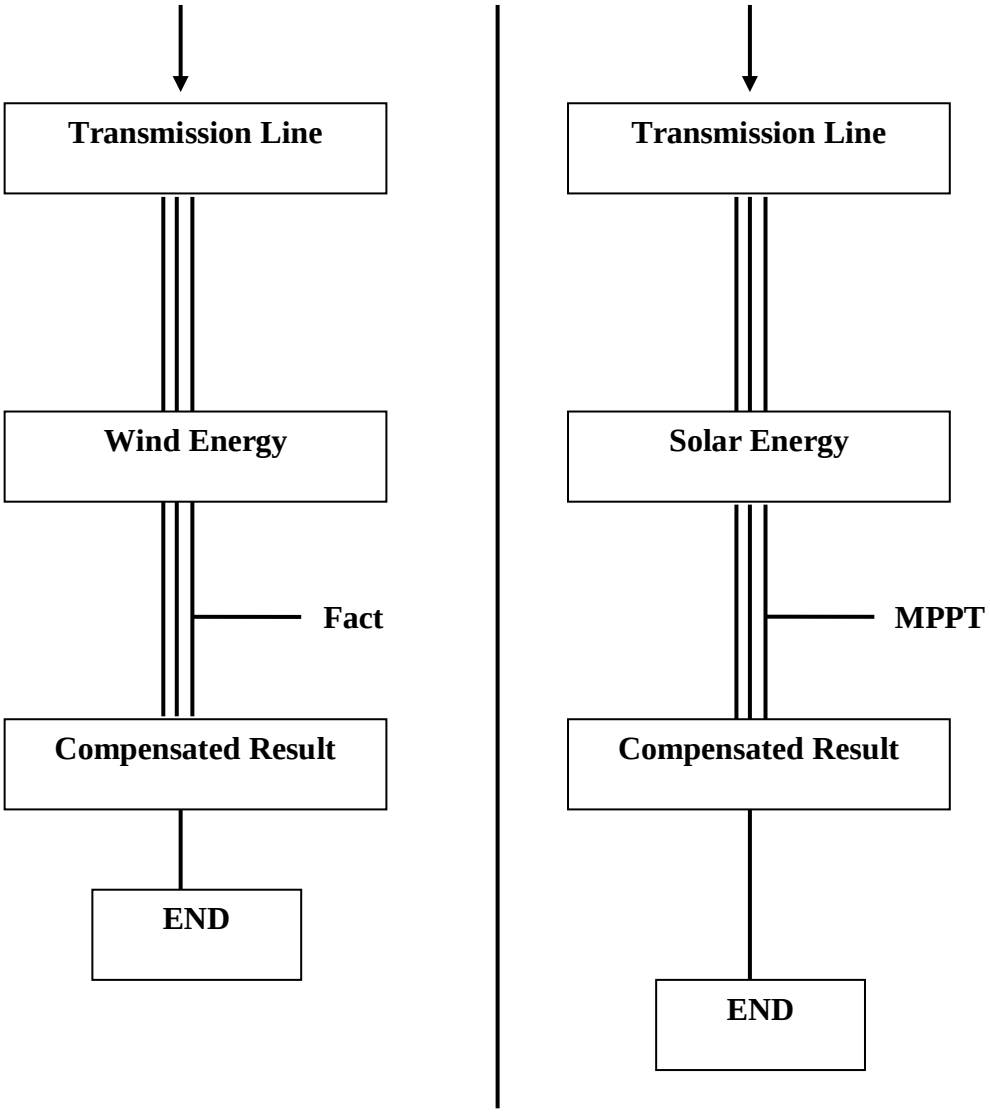
In recent years, wind power and solar power is highly developed in many countries. Because due to the limitation of fossil fuels and environment issues. But the main issue in wind power is stability. This is not constant because the wind is not constant at all time. Due to this, the stability problems accurse and quality of power is also reduced. But now days, many types of facts devices are used for power quality improvement. The STATCOM are the first generation facts devices which are used for power quality improvement The fluctuation which is generated by the wind turbine is compensated by fact devices and MPPT controller. In this research we tried to compare power quality improvement of wind energy system using fat devices for wind and solar energy. Various types of power quality issues and facts devices are described, which affect the power factor of transmission line.

1.9 Thesis Layout

This work for power quality improvement based on wind and solar energy with fact device. This work completely describes the operation of the photovoltaic cell and the conversion of solar energy to electrical energy.

Chapter 1 introduce introduction of the research. chapter 2 will discuss about the literature review of the research along with chapter 3 will discuss about the proposed work along with matlab introduction.

Chapter 4 and 5 will discuss about the solar energy and wing energy power quality assessment with result discussion with STATCOM and MPPT Device. Chapter 6 will be conclusion and future scope of work.



Flow Chart

2 REVIEW OF LITERATURE

A. Jeyamari et. al. [17] presented the infusion of the breeze power into an electric lattice influences the force quality. The impact of the breeze turbine in the lattice framework concerning the force quality estimations and the standards followed by the rules determined in the International Electro specialized Commission standard, IEC61400 are the dynamic and receptive force varieties, variety of voltages, glimmer, sounds and electrical conduct of exchanging activities. The paper study exhibits has generally great useful attributes, preferable execution and quicker reaction over existing frameworks. The roposed means of

having STATCOM is more modest in size and less expensive when contrasted with the current framework. In this proposed framework static compensator (STATCOM) is associated at a state of normal coupling with a battery energy stockpiling framework (BESS) to lessen the force quality issues. The viability of the proposed conspire gives the responsive force interest of burden and the acceptance generator. Reproduction is finished by utilizing MATLAB/SIMULINK-Sim power framework programming.

Sarita Samal et. al. [18] presented the genuine issues in lessening of force quality happens because of the fast development of nonlinear burden are prompts unexpected abatement of source voltage for a couple of moments i.e hang, expand, music in source and burden current, voltage unbalance and so forth This load of issues can be remunerated by utilizing Unified Power Quality Controller (UPQC) and the activity of UPQC relies on the accessible voltage across capacitor present in dc connect. Assuming the capacitor voltage is kept up with consistent, it gives acceptable execution. The proposed research is fundamentally on planning of Photo Voltaic (PV)/Wind energy took care of to the dc interface capacitor of UPQC to keep up with appropriate voltage across it and work the UPQC for power quality investigation. The said model is reproduced in Matlab and results are confirmed by utilizing FFT investigation. The proposed PV/Wind energy-UPQC is plan in Matlab reproduction for decrease of voltage droop, grow, interference of voltage, music in load current and remuneration of dynamic and receptive force.

Sanjeev H. Kulkarni, et. al. [19] Proposed with development of cutting edge innovations and critical prerequisite for keeping a solid climate with sensible value, India is moving towards a pattern of producing power from sustainable assets. Wind energy creation, with its moderately more secure and positive ecological qualities, has developed from a negligible movement into a multibillion dollar industry today. Wind energy power plants, otherwise called wind ranches, involve various breeze turbines. However there are a few breeze factory Clusters creating energy in various topographical areas across the world, assessing their exhibition is a mind boggling task and is a significant concentration for partners. In this work an endeavor is made to appraise the exhibition of wind groups utilizing a multi standards approach. Numerous elements that influence wind ranch tasks are investigated by taking specialists feelings, and an exhibition positioning of the breeze ranches is created. The loads of the determination standards are dictated by pair astute correlation lattices of the Analytic Hierarchy Process (AHP).The proposed system assesses wind ranch execution dependent on

specialized, monetary, ecological, and sociological markers. Both subjective and quantitative boundaries were thought of. Observational information were gathered through poll from the chose wind homesteads of Belagavi area in the Indian State of Karnataka. This proposed approach is a valuable instrument for bunch investigation.

Md Mujahid Irfan et. al. [20] proposed network intuitive sunlight based photovoltaic (PV) and electric vehicle (EV) frameworks are the arising innovations these days, mostly because of energy cost decrease and minimization of discharge levels. Different examination studies have introduced the impact of matrix joining of PVs and EVs in a disconnected manner. Notwithstanding, it merits tolerating that with the constant rise of PVs and EVs, the force network is encountering the consolidated impact of PV–EV incorporation. The dissemination framework organization of EVs impacts the force nature of the network. In this paper, shunt dynamic force channel is displayed utilizing neuro-fluffy control strategy for the moderation of sounds utilizing MATLAB. The improvement in the framework execution is dissected and contrasted and the customary pay methods.

Majid A. Abdullah, et. al. [21] revealed this paper audits and studies the best in class of accessible greatest force point following (MPPT) calculations. Because of the idea of the breeze that is promptly evolving, subsequently, there is just a single ideal generator speed is alluring at one time that ensures the most extreme energy is gathered from the accessible breeze. Accordingly, it is fundamental to incorporate a regulator that can follow the most extreme eak paying little heed to any wind speed. The accessible greatest force point following (MPPT) calculations can be arranged by the control variable, specifically with and without sensor, and furthermore the method used to find the most extreme pinnacle. A correlation has been made on the presentation of the chose MPPT calculations based on different speed reactions and the capacity to accomplish the most extreme energy yield. The following presentation is performed by mimicking wind energy framework utilizing MATLAB/Simulink reproduction bundle. Other than that, a brief and basic conversation is made on the distinctions of accessible MPPT calculations for wind energy framework. At last, an end is drawn.

Varun Kumar et. al. [22] revealed this paper presents a survey on lattice Integration and force quality issues related with the mix of environmentally friendly power frameworks in to matrix and Role of force electronic gadgets and Flexible AC Transmission Systems identified

with these Issues. In this paper, late patterns in power hardware for the reconciliation of wind and photovoltaic (PV) power generators are introduced. Conversations about normal and future patterns in environmentally friendly power frameworks dependent on unwavering quality and development of every innovation are introduced. Order of different Power Quality Issues utilized by various analysts has been done and put for reference. Use of different procedures as applied to alleviate the diverse Power Quality issues is likewise introduced for thought. Force Electronics interface not just assumes a vital part in proficient combination of Wind and Solar energy framework yet in addition to its impacts on the force framework activity particularly where the sustainable power source comprises a critical piece of the all out framework limit.

B. V. V. L Kala bharathi et. al. [23] indicated the produced power from environmentally friendly power source is continually fluctuating because of ecological conditions. Coordinating these inexhaustible sources to matrices to any significant degree can open the framework to issues that need consideration in case the usefulness of the matrix be disabled. Similarly wind power infusion in to an electric framework influences the force quality because of the vacillation idea of the breeze. This undertaking shows the presence of the force quality issues because of the establishment of wind turbine with framework. To moderate these force quality issues, this undertaking proposes a plan dependent on FACTS gadget called SVC light which is associated at a PCC. The proposed model is contrasted and the model that don't utilize any repaying gadget .Performance of the framework with BESS under load varieties and Fault ride through ability of the svc light is likewise broke down. This control plot for the matrix associated wind energy age framework to further develop power quality is recreated utilizing MATLAB or SIMULINK in power framework block set.

R. Dehini et. al. [24] indicated oil, coal and gas keep on being the most requested wellspring of energy all through the world along. As of late, the disturbing fall in measures of non-renewable energy sources and expansion in climatic carbon dioxide creation have been seen on a few events. These impediments of petroleum products orientate the specialists toward sustainable power sources as a more strong long haul arrangement. The point of this paper is to introduce a shunt dynamic force channel (PAPF) provided by the Photovoltaic cells ,so that the (PAPF) takes care of the straight and nonlinear burdens by sounds flows and the abundance of the energy is infused into the force framework. To work on the exhibitions of ordinary (PAPF) This paper likewise proposes fake neural organizations (ANN) for sounds

ID and DC interface voltage control. The recreation concentrate on consequences of the new (SAPF) ID method are observed to be very palatable by guaranteeing great sifting attributes and high framework soundness.

Lokesh Vitonde et. al. [25] presented environmentally friendly power sources are elective energy source, can bring new difficulties when it is associated with the force network. At the point when the breeze power is associated with an electric network influences the force quality. The impacts of the force quality estimations are-the dynamic force, responsive force, variety of voltage, glimmer, sounds, and electrical conduct of exchanging activities. The establishment of wind turbine with the framework causes power quality issues are dictated by concentrating on this paper. For this Static Compensator (STATCOM) with a battery energy stockpiling framework (BESS) at the purpose in like manner coupling to moderate the force quality issues. The lattice associated wind energy age framework for power quality improvement by utilizing STATCOM-control plot is reproduced utilizing SIMULINK in power framework block set. This remembers the fundamental inventory source from the responsive force interest of the heap and the acceptance generator in this proposed conspire. The paper study exhibits the force quality issue because of establishment of wind turbine with the framework. Likewise the improvement in power quality on the matrix has been introduced here as per the rules indicated in IEC-61400 norm (International Electro-specialized Commission) gives a few standards and estimation

Pavitra Shukl et. al. [26] presented a genuine concern in regards to disintegration in power quality, has arisen with the expanding joining of sun oriented photovoltaic (PV) energy sources to the utility principally in the situation of frail dispersion matrix. In this manner, power quality improvement of the framework tied sun oriented energy change framework is foremost by execution of a vigorous control method. This work manages a delta-bar-delta neural organization (NN) control for working ideally by taking care of dynamic capacity to the heaps and remaining capacity to the matrix as a component of circulation static compensator (DSTATCOM) abilities like alleviating sounds, adjusting of burden and further developing force factor. The control calculation gives the capacity to change loads adaptively in an autonomous way and henceforth it offers easing in model intricacy prevalent during strange matrix conditions alongside decrease in computational time. Additionally, the neural organization based control method offers upgraded exactness because of the combinational neural construction in the assessment cycle. What's more, the framework execution as

indicated by the IEEE-519 norm, has been confirmed subsequently, it is capable in keeping up with the force quality. The sun based PV cluster effective use is refined through a steady conductance (INC) based most extreme force point following (MPPT) strategy. For approving the conduct of proposed framework, its exhibition is concentrated on utilizing reenactment results. Besides, a model is produced for approval and test results validate dependable activity under non-ideal framework conditions containing wide scope of burden varieties, voltage list and differing sun based insolation conditions.

Akhilesh Kumar et. al. [27] proposed this paper gives outline of wind energy improvement from old period to present and zero in on matrix power age just as wind power age. By looking at wind power age, it has expanded instant contrasted with last 3 dotages. Because of fast prerequisite of wind power, power converter innovation put a significant job in fostering the breeze power age. Since the breeze energy innovation is exceptionally perplexing for creating wind energy viably so in this paper we are centering for a responsive force control technique because of which the yield force can be control adequately by utilizing Static Synchronous Compensator called COM .Since in wind power age it is extremely fundamental to get variable yield. Furthermore, STATCOM can differ the yield agreeing the prerequisite by engrossing or producing the receptive force in the framework. For perceiving the likely issues and arranging a framework to diminish them, a comprehensive ability is required. Planning raised measures of wind control calls for moreover control and compensating kinds of stuff to empower recovery from structure disrupting impacts with significant degree of reality. This paper throws light into using satisfactorily, a Static Synchronous Compensator (STATCOM) for settling the lattice voltage following organization side agitating impacts.

Arun Kumar Verma et. al. [28] proposed this paper presents a clever idea of using sun oriented photovoltaic (SPV) producing frameworks to further develop the force factor to solidarity or to manage a voltage at reason behind normal coupling (PCC) of a three stage framework. A three-stage VSC (voltage source converter) of this framework takes out music flows, balances stacks and remunerates receptive force for power factor amendment (PFC) or zero voltage guideline (ZVR) at AC mains. The VSC comprises of a DC transport capacitor at its DC transport which is taken care of by SPV energy. DC voltage PI regulator directs the DC transport voltage at the hour of burden variety. The lattice interfaced sun oriented PV power creating framework is tried for PFC and ZVR method of activity alongside music flows end and burden adjusting of straight and nonlinear burdens.

Mr. Ramesh Daravath et. al. [29] revealed the essential point of shunt remuneration in a circulation framework is to drop or smother the impact of consonant substance in burden with the end goal that current drawn from the source is almost sinusoidal. At the point when acceptance machine driven by wind turbine is synchronizing with electrical matrix framework, different force quality issues emerge, for example, voltage list, enlarge, flash, music and so on In this plan the STATCOM is associated at the reason behind purpose in like manner coupling with a Battery energy stockpiling framework (BESS) to relieve power quality issues. The control conspire utilized is Bang-Bang regulator. A Bang-Bang regulator otherwise called on-off regulator or hysteresis regulator is a criticism regulator that switches unexpectedly between two states. These regulators might be acknowledged as far as component that gives hysteresis. This control plan will be reproduced utilizing MATLAB/simulink.

Bhim Singh et. al. [30] revealed this paper manages the plan, demonstrating, and execution of a photovoltaic (PV) cluster interfaced with a DC–DC support converter taking care of three-stage lattice tied voltage source converter. The framework utilizes an Instantaneous Reactive Power Theory based control calculation and is worked in solidarity power factor mode. This three-stage shunt-associated sunlight based PV energy change framework is additionally utilized for load flows sounds end, power factor rectification, receptive force remuneration, and matrix flows adjusting in a three-stage conveyance framework. A Perturb and Observe-based maximum power point following calculation is utilized to produce greatest force from the PV exhibit. This framework is planned and displayed, and its exhibition is confirmed through reenactment in MATLAB/Simulink. A model of the proposed environmentally friendly power framework is created in the lab utilizing an advanced sign processor to approve its plan and control.

Sheeraz Kirmani et. al. [31] indicated electric Power Quality (EPQ) is a term that alludes to keeping up with the close to sinusoidal waveform of force dissemination transport voltages and flows at evaluated extent and recurrence". Today clients are more mindful of the reality that the force quality has, this brief the utilities to guarantee great nature of capacity to their client. The force quality is fundamentally client driven. Expanded focal point of utilities toward keeping up with dependable force supply by utilizing power quality improvement instruments has decreased the blackouts and dark out extensively. Great force quality is the

trait of dependable force supply. Low force factor, consonant contamination, load irregularity, quick voltage varieties are some normal boundaries which are utilized to characterize the force quality. On the off chance that the force quality issues are not checked for example the boundaries that characterize power quality doesn't fall inside the predefined norms than it will lead into high power charge, high running expense in businesses, failing of supplies, challenges in associating sustainable. Capacitor banks, FACTS gadgets, consonant channels, SVC's (static voltage compensators), STATCOM (Static-Compensator) are the answers for accomplish the force quality. The presentation of Wind turbine generators is influenced by low quality force, simultaneously these breeze power producing plant influences the force quality contrarily. This paper presents the STATCOM-BESS (battery energy stockpiling framework) framework and studies its effect on the force quality in a framework which comprises of wind turbine generator, non straight burden, hysteresis regulator for controlling the activity of STATCOM and lattice. The model is recreated in the MATLAB/Simulink. This plan mitigates the force quality issues, further develops voltage profile and furthermore lessens symphonious mutilation of the waveforms. BESS level out the uneven characters caused in genuine force because of irregular nature of wind power accessible because of fluctuating breeze speeds.

C. Shiva et. al. [32] indicated at present, power quality is one of the key components, which impacts the economy of a country. Because of ascending of populace utility supplies overabundance ability to fulfill the expanding need of the purchasers. To keep up with the contamination and the an unnatural weather change inside the specific level substitute wellsprings of energy have utilized which devolops the contamination less climate. To beat those issues nonconventional energy come into picture. The entire exhibition of the electrical utility can be improved by the utilization of non-regular energy assets. There are various types of Renewable Energy Asset (RES) are accessible. Among them sunlight based energy is generally utilized in light of the fact that it is bounteously accessible in nature. Furthermore it has parcel of benefits like no air contamination, no fuel cost, silent and low support. Incorporating sunlight based capacity to the lattice has antagonistic impact on the force quality in the framework. In a couple of PV based structure, the inverter is a key section which is answerable for the control of force stream between the dc source, and loads or grid. This paper portrays the challenges and issues in the space of force quality the because of the incorporation of sunlight based force in to framework are to be investigated. The Shunt

Active Power Filter (SAPF) with PI regulator is to be intended to upgrade power quality in the matrix coordinated nearby planet group.

Sener Agalar 1et. al. [33] presented as of late, environmentally friendly power has drawn in unique interest since it is by all accounts a positive option in contrast to fossil 11 powers. European nations, specifically, and numerous other created nations on the planet have been in search 12 of using wind energy to address the issue for energy. The motivation behind this review is the use of 13 the breeze energy in a more secure and greater quality manner. Two frameworks were recommended for expanding the nature of 14 the breeze energy. In the principal framework, the breeze energy and the network were associated in corresponding with the assistance of 15 static exchange switch (STS), and if the breeze energy is cut, the heap will be upheld by the elective 16 feeder. In the subsequent framework, dynamic voltage restorer (DVR) was associated with wind energy framework (WES). 17 The expectation is, with the assistance of DVR framework, forestalling the vacillations that may occur in the energy 18 that is created, because of the varieties of wind speed. Both framework circuits that are proposed have been 19 made in PSCAD/EMTDC program and the responses of the circuits in the circumstance of a blunder was 20 examined exhaustively. The activity standards of STS and DVR have been clarified exhaustively and afterward the 21 recreation results have been completely researched with PSCAD/EMTDC program. The point of the 22 created frameworks is to keep up with the force congruity and further develop the force quality. Distinctive shortcoming types 23 were applied to the proposed frameworks and the framework reactions for these unsettling influences were inspected.

Denisa Galzina et. al. [34] presented sunlight based force and wind are the most encouraging conveyed energy sources. The photovoltaic framework has drawn in critical consideration lately. Despite the fact that their advantages are various, they are known to make power quality issues, on account of the force electronic converters they use. This paper explores in case there is plausible to further develop power quality exclusively by associating a sun oriented photovoltaic framework to the matrix, and afterward gives aftereffects of on location power quality estimations in the lattice prior and then afterward the association of the sun based photovoltaic framework.

S. Adhithyan et. al. [35] proposed the alleviation of force quality aggravations in network associated wind energy change framework utilizing dynamic voltage restorer will be talked about in this paper. Wind power infusion into an electrical network will be additionally

influences the force quality. In wind turbines especially of acceptance type can draw lot of receptive force from the lattice. The DVR is introduced between the source voltage and basic or touchy burden. The arrangement of DVR can be proposed by utilizing PI regulator. To limit the receptive force trade among network and wind generators and relieve the force quality unsettling influence the responsive force can be infused to the matrix by utilizing DVR. The recreation model of the framework will be created and result will be gotten by MATLAB/SIMULINK programming.

Sarita Samal et. al. [36] proposed the genuine issues in lessening of force quality happens because of the quick development of nonlinear burden are prompts unexpected abatement of source voltage for a couple of moments i.e droop, expand, sounds in source and burden current, voltage unbalance and so forth This load of issues can be remunerated by utilizing Unified Power Quality Controller (UPQC) and the activity of UPQC relies on the accessible voltage across capacitor present in dc interface. In the event that the capacitor voltage is kept up with consistent, it gives acceptable execution. The proposed research is essentially on planning of Photo Voltaic (PV)/Wind energy took care of to the dc interface capacitor of UPQC to keep up with appropriate voltage across it and work the UPQC for power quality examination. The said model is recreated in Matlab and results are confirmed by utilizing FFT examination. The proposed PV/Wind energy-UPQC is plan in Matlab reenactment for decrease of voltage droop, grow, interference of voltage, music in load current and pay of dynamic and responsive force.

K. Veeresham et. al. [37] revealed it is the investigation of further developing force quality in which wind energy is associated with electrical energy through a circulated D-STATCOM, which is associated with the framework. This review comprises of a breeze turbine associated with a doubly-took care of enlistment generator, voltage sourced inverter which is associated with the utility through the purpose in like manner coupling. As the review manages the multifunctional highlights an immediate force control is proposed. This immediate force likewise diminishes sounds prior to interfacing with utility and furthermore decreases receptive force. Also, this framework guarantees the productivity of the framework. The control calculation is proposed in this review is particularly successful in infusing dynamic force into the framework, accordingly decreases consonant flows and making up for receptive force.

Albert Alexander Stonier et. al. [38] revealed the presence of music in sunlight based Photo Voltaic (PV) energy change framework brings about decay of force quality. To resolve such issue, this paper means to research the disposal of music in a sun oriented took care of fell fteen level inverter with help of Proportional Integral (PI), Arti cial Neural Network (ANN) and Fuzzy Logic (FL) based regulators. In contrast to different procedures, the proposed FLC based methodology helps in acquiring decreased consonant mutilations that expect to an improvement in power quality. Notwithstanding the force quality improvement, this paper likewise proposed to give yield voltage guideline as far as keeping up with voltage and recurrence at the inverter yield end in viable with the lattice association necessities. The reenactments are acted in the MATLAB/Simulink climate for sun based took care of fell 15 level inverter fusing PI, ANN and FL based regulators. To show the proposed procedure, a 3 kWp photovoltaic plant coupled to staggered inverter is planned and equipment is illustrated. Every one of the three procedures are tentatively examined with the estimation of force quality measurements alongside building up yield voltage guideline.

Ashish K Duchakke et. al. [39] indicated infusion of the breeze power into an electric lattice influences the force quality. The impact of the breeze turbine in the lattice framework concerning the force quality estimations are-the dynamic force, receptive force, variety of voltage, gleam, music, and electrical conduct of exchanging activity and these are estimated by public/worldwide rules. The venture exhibits the force quality issue because of establishment of wind turbine with the matrix. In this proposed conspire STATic COMpensator (STATCOM) is associated at a state of normal coupling with a battery energy stockpiling framework (BESS) to alleviate the force quality issues. The battery energy stockpiling is incorporated to support the genuine force source under fluctuating breeze power. The STATCOM control plot for the lattice associated wind energy age framework for power quality improvement is reproduced utilizing MATLAB/SIMULINK in power framework block set. The adequacy of the proposed conspire remembers the fundamental inventory source from the responsive force interest of the heap and the acceptance generator.

Natthanon Phannil et. al. [40] indicated photovoltaic (PV) energy has been generally intrigued today since it is spotless and unending energy without causing contamination. To create power from sunlight based energy, it would be required an inverter to change over the immediate current into exchanging current. The inverter is the reason for issues that influence the soundness of the force framework since it is an exchanging gadget served to change the

recurrence of the AC power depending on the situation. Simultaneously, it can cause music which bring about waveform mutilation and influence electronic gadgets that get power. Then, at that point, it could make electronic gadget glitch. This paper concentrates on the attributes of music on matrix, PV framework, and burden. The outcome shows that most network's music are influenced from PV framework and burden when the inverter power up to practically the appraised power, in the interim, rates of sounds are decreased and music of burden rely upon the sort of burden. Then, contrasting sounds on three sides, and found that music of PV framework scarcely influence to load and music of lattice are more influenced from load than PV framework.

Manindher K G et. al. [41] proposed age of ability to satisfy the heap need is actually a test as of late. In this contemporary world the development of populace and industrialization drives a primary job for appeal in power age, which can't be just fulfill utilizing non-inexhaustible sources. Henceforth it is important to fulfill the need utilizing sustainable power assets like breeze, biomass, sun oriented, flowing, etc. Taking care of wind power into matrix framework liable to influences the nature of force, for example, voltage rise, voltage hang, glints, and sounds, etc. It tends to be survived and improved by utilizing static simultaneous compensator (STATCOM) in the Grid associated wind energy framework. The breeze energy frameworks are associated and assessed utilizing the MATLAB/SIMULINK Software.

Jayasankar V N et. al. [42] presented energy request increments quickly, use of sustainable power assets makes light of a significant job in narrowing the inventory request distinction. Presentation of more force electronic gadgets and non-straight loads dirties the lattice and make power quality issues. Both the shortage of energy issue and force quality issue can be all the while addressed by utilizing the matrix interfacing inverter of inexhaustible sources, as a shunt dynamic channel. An appropriate control technique must be utilized for giving framework interfacing inverter, the force of force quality improvement. Traditional PI regulator can be supplanted with a fluffy regulator for better control, and in this way further develop the framework execution. In this paper, a matrix associated crossover arrangement of wind-sun based with power quality improvement highlights is mimicked with a PI regulator, and afterward results are contrasted by supplanting PI and fluffy regulator.

Sangam Sai Chandramouli et. al. [43] presented to settle the impact of nonlinear and unbalance blended burdens on yield of voltage source inverters in PV-Grid associated frameworks, the different control systems can be utilized to decrease the sounds, keep up with precise force dissemination, negative arrangement voltage part concealment and dependability improvement. The force quality issues are serious issues in the force age, transmission and dissemination frameworks. In this paper, the force quality improvement control strategies that are utilized in network associated PV framework are clarified and the MPPT techniques are inferred.

Ravi. Dharavath et. al. [44] revealed the utilization of force is more because of high creation and more number burdens. The vast majority of the heaps are nonlinear burdens, causes the consonant flows in the framework. These consonant flows thus make framework reverberation, capacitor over-burdening, decline in proficiency, voltage greatness changes. Force quality has turned into an expanding worry to utilities and clients. The force sending in a circulation line is should have been of great. One of the significant force quality issues is considered in the appropriation framework called Voltage hang and can relieve with the assistance of dynamic voltage restorer. In this paper, Focusing on the original coordination of sunlight based PV-Battery based Dynamic Voltage Restorer is carrying out in the circulation framework to meet the essential force and for power quality improvement. Sun based photovoltaic with help converter is carried out by gradual conductance technique to follow the Maximum force. The presentation of sun powered photovoltaic, Battery with Dynamic Voltage restorer is recreated under unique states of the heap in MATLAB-SIMULINK programming.

Indulekha K M, et. al. [45] proposed the renewable Energy Sources (RES) are as a rule progressively utilized during late years. The combination of RES to the network presents power quality issues at the dispersion level. Furthermore, the utilization of straight/nonlinear unequal burdens made force quality as one of the significant issues looked by the electrical business. In this paper a breeze energy change framework with power quality improvement highlights is depicted. Super durable Magnet Synchronous Generator (PMSG) based breeze power age framework displaying is finished. A control system for the matrix interfacing inverter with hysteresis current control is created to further develop power quality. The framework interfacing inverter is controlled in such a way that the mix of lattice interfacing inverter alongside direct/nonlinear lopsided burden shows up as adjusted straight burden to

the matrix at PCC. Broad reproduction studies are completed in Matlab/Simulink to approve the proposed control approach.

Sarkut Ibrahim et. al. [46] indicated this paper presents investigation and improvement of force quality (voltage hang, swell and music) execution of shrewd network associated inverter utilized in circulated age. The construction of the planned regulator comprises of external force with symphonious control circle, center voltage control circle and internal current control power circle no doubt and receptive force control in dq reference outline .The created regulator controls the genuine and responsive force provided by the DG(Distributed Generation) at the PCC(Power Controlled Converter). The regulator is intended to convey current at solidarity power factor at PCC. An increment in responsive force interest and music at PCC because of progress of burden and lattice impedance variety, would influence the framework voltage at PCC. Environmentally friendly power assets (RES) are as a rule progressively associated in dissemination frameworks using power electronic converters. This report presents a clever control technique for accomplishing greatest advantages from these framework interfacing inverters when introduced in 3-stage 4-wire circulation frameworks. The inverter is controlled to proceed as a multi-work gadget by consolidating dynamic force channel usefulness.

3 INTRODUCTION TO FACTS

Adaptable AC transmission Systems, called FACTS, got in the late A long time An great referred to haul to higher controllability done control frameworks by method for control electronic gadgets. A few FACTS-devices have been acquainted to Different provisions overall. An number for new sorts for units need aid in the stage about constantly brought On act.

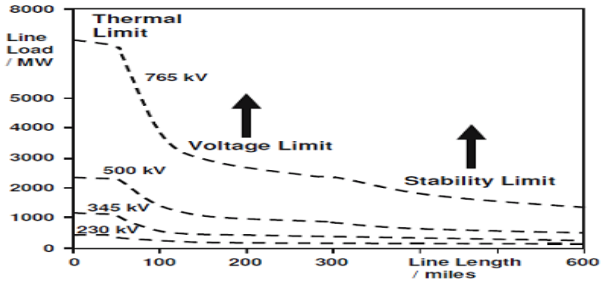
Clinched alongside the vast majority of the requisitions those controllability is used to Abstain from expense escalated consideration or scene requiring extensions of control systems, for example similar to upgrades or additions for substations force lines. FACTS-devices give acceptable a exceptional adjustment on changing operational states move forward those utilization about existing installations. The fundamental provisions about FACTS-devices are:

- Energy stream control,
- Build for transmission capability,

- Voltage control,
- Sensitive force compensation,
- Strength improvement,
- Energy nature improvement,
- Energy conditioning,
- Gleam mitigation,
- Intercontinental of renewable Also dispersed era and storages.

Figure indicates the fundamental thought for Realities for transmission frameworks. The utilization from claiming lines for animated energy transmission ought to a chance to be ideally dependent upon the warm breaking points. Voltage and Strength cutoff points ought be moved with those method for those a few different Realities gadgets. It camwood be seen that with developing offering length, the chance for Realities units gets an ever increasing amount significant.

Those impact of FACTS-devices will be attained through switched alternately controlled shunt compensation, arrangement payment or period shift control. Those units fill in electrically as quick current, voltage alternately impedance controllers. The force electronic permits exceptionally short response times down on significantly underneath person second.



Operational limits of transmission lines for different voltage levels

Fig. 1

The advancement about FACTS-devices need off with the developing abilities for force electronic parts. Units for helter skelter force levels bring been produced accessible over converters for helter skelter Furthermore actually most elevated voltage levels. The Generally speaking beginning focuses are system components influencing the sensitive control alternately those impedance of a and only those force framework. Figure 1. 2 demonstrates An number of fundamental units divided under the customary ones and the FACTS-devices.

To those Realities side those scientific classification As far as 'dynamic' and 'static' necessities a few illustration. The term 'dynamic' is used to express the quick controllability

about FACTS-devices Gave by those control hardware. This is a standout amongst those principle separation variables starting with the customary gadgets.

The expression 'static' implies that those units need no moving parts like mechanical switches with perform those dynamic controllability. Consequently A large portion of the FACTS-devices could just as be static element.

3.1 Types of Facts Devices:

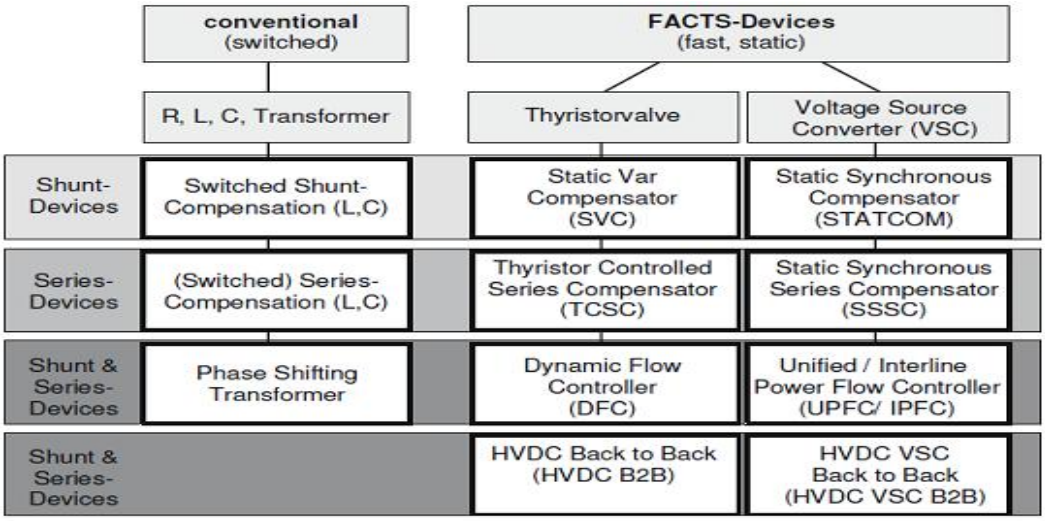


Fig. 2

The exited section to figure 1. 2 holds the accepted units Fabricate crazy for settled or mechanically switchable parts like resistance, inductance or capacitance together for transformers. The FACTS-devices hold numerous these components and also blacks Yet utilization extra force electronic valves alternately converters on switch those components clinched alongside more diminutive steps alternately with exchanging examples inside a cycle of the exchanging current. The left section for FACTS-devices employments Thyristor valves alternately converters. These valves alternately converters would great known since a few a considerable length of time. They have low misfortunes due to their low exchanging recurrence about once An cycle in the converters or the utilization of the Thyristors should basically span impedances in the valves.

Those correct section for FACTS-devices holds additional propelled engineering about voltage hotspot converters based today basically once Insulated entryway bipolar Transistors (IGBT) or Insulated entryway Commutated Thyristors (IGCT). Voltage sourball Converters furnish a nothing controllable voltage clinched alongside extent Furthermore period because of a pulse width regulation of the IGBTs or IGCTs. Helter skelter regulation frequencies permit with get low sounds in the yield sign Furthermore actually on adjust

disturbances nearing starting with those system. Those disservice may be that with a expanding exchanging frequency, the misfortunes would expanding too. Subsequently exceptional outlines of the converters need aid needed will adjust this.

FACTS controllers are usually based on power devices with gate turn-off or thyristor devices without gate turn-off capability. The growth of power semiconductor equipment with capability (GTO, MCT) have had great influence in the FACTS devices development. FACTS devices play an important role to make the generation of electrical energy more economically. Also they are compliant with the environment [15]. FACTS controllers can be used for the impedance and phase angle of high voltage AC transition's lines and the dynamic voltage control. FACTS devices are classified under 3 categories [15]: 1. Series controllers. 2. Shunt controllers. 3. Combined series-series controllers. 4. Combined series-shunt controllers. Among above-mentioned categories, the shunt FACTS devices like Static Synchronous Compensator (STATCOM) is the most popular one to supply smooth swift steady state and transient voltage control over the grid [14].An evaluation of the application of a STATCOM which is equipped with doubly fed induction generators (DFIGs) in a wind mill at the time of disturbance have been done in [16].

4 PHOTOVOLTAIC ENERGY AND MPPT

4.1 Background

Renewable energy sources perform a significant role in electric power generation. There are various renewable sources which used for electric power generation, such as wind energy, PV energy, geothermal etc. PV energy is a good choice for electric power generation, since the PV energy is directly converted into electrical energy by photovoltaic modules. These modules are made up of semiconductor cells. When many such cells are connected in series and parallel combinations we get a solar PV module. The current rating of the modules increases when the area of the individual cells is increased, and vice versa. The increase of world energy request and the environmental concerns lead to an increase of the renewable energy production over the last decade. Energy sources such as solar, wind or hydro became more and more popular mainly because they produce no emissions and are limitless. PV energy is the fastest growing renewable source with a history dating since it has been first used as power supply for space satellites. The increased efforts in the semiconductor material technology resulted in the appearance of commercial PV cells and consequently made the PVs an important alternative energy source [1]. One of the major advantage of PV technology is the lack of moving parts which offers the possibility to obtain a long operating

time (>20 years) and low maintenance cost. The main drawbacks are the high manufacturing cost and low efficiency (15-20 %). As one of the most promising renewable and clean energy resources, PV power development has been boosted by the favorable governmental support [2].One of the most important problems facing the world today is the energy problem. This problem is resulted from the increase of demand for electrical energy and raised of fossil fuel prices. Another problem in the world is the global climate change has increased. As these problems alternative technologies for producing electricity have received greater attention. The most important solution was in finding other renewable energy resources [3], [4].

4.1.1 Renewable Energy

Each year, the addition of persons to world will increase and the resources required to support them will also increase. Of the resources, one of the most dynamic to support the technological advancing population is energy. The energy crisis became transparent in the late 1900‟s and birthed the desire to find additional energy resources to meet rising energy demands [5]. One choice was to increase generation of currently used energy sources such as nuclear, fossil fuel, etc. The other was to explore new renewable energy alternatives. Many different renewable energy sources have appeared as feasible solutions and each one of them has their own positive and negative attributes. As a whole, renewable energy sources all share the fact that their fuel is primarily free and they produce minimal to no waste. These factors are the main motivation for countries to begin incorporating renewable into their energy collection. A predictable 19% of global energy consumption in 2013 was supplied by renewable energy [6]. One more analysis of where the world's energy came from in 2013 is shown in Fig. 3. Only 19% of global energy coming from renewable may not seem to be a vast amount; however in 2013 nearly half of the new electric power capacity installed was from renewable alone. The percentage of energy from renewable has increased every year for the past several years, and is predicted to continue with this trend in the future.

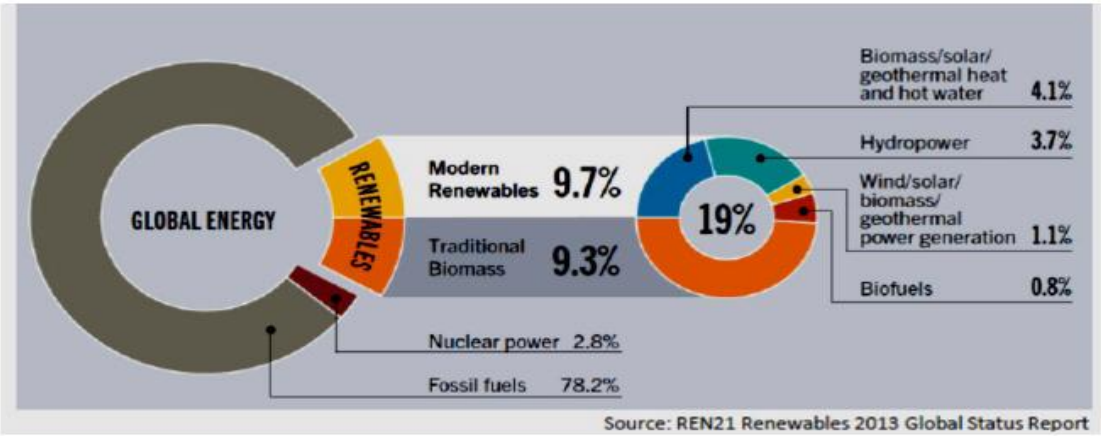


Fig. 3 Renewable energy share of global electricity production, 2013 [6].

Further analyzing Fig. 3, the largest source of energy used globally is fossil fuels [7]. Two of the largest other sources of energy are nuclear and hydropower. Fossil fuels are non-renewable and generate harmful pollution when burned for energy. Nuclear power plants have the potential to be a great energy source. However, they generate toxic nuclear waste that has to be buried and also always poses the risk of a meltdown, which could be catastrophic for the neighboring environment. Hydropower generation requires damming a river or body of water, disrupting its natural flow, and completely changing the surrounding ecosystem. A form of renewable energy gaining recent popularity is solar [8]. Solar energy is one of the cleanest forms of energy available, converting energy from the sun to electricity without any waste or harmful by products.

4.1.2 Solar Energy

It's the energy which derivative from the sun through the form of solar radiation. Solar powered electrical generation relies on photovoltaic. A partial list of other solar applications includes space and water heating, solar cooking, and high temperature process heat for industrial purposes.

4.1.2.1 The Photovoltaic Resource

The PV energy is an extremely powerful energy; actually the earth‟s surface receives enough energy from the sun in one hour to meet its energy requirements for one year [8]. PV technology was originally created to power some of the first satellites used in space in the 1950‟s [7]. When the technology was in its early form its uses were limited, to such applications as space, due to economic practicality. However, in the last five years the PV market has experienced rapid growth. From 2010 to 2012 an additional 60 GW of new PV

capacity was added globally, bringing the total world capacity to 100 GW [6]. Fig. 4 shows the exponential increase, especially over the last five years of PV capacity.

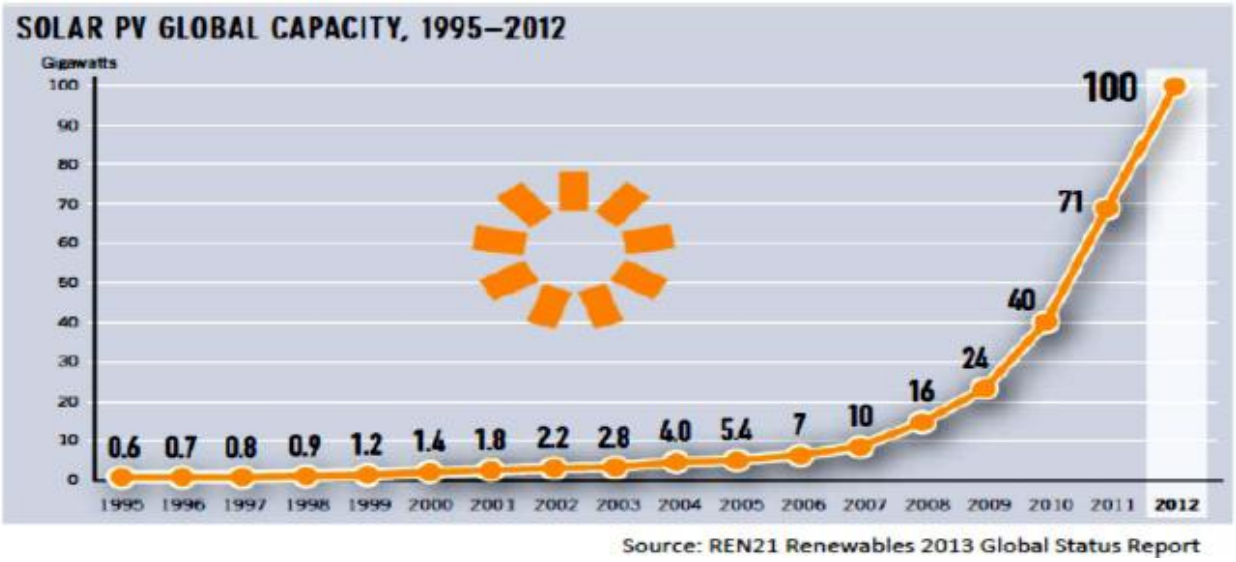


Fig. 4 Total World Capacity of PV (1995-2012) [6].

The growth of installed PV can be recognized to many factors but the main reasons are increases in environmental considerations, new state laws and regulations, purchase incentives, increases in PV cell technology and efficiency, and decreases in overall system cost [7].

4.2 Photovoltaic Background

Solar panels are made up of photovoltaic cells; it means the direct conversion of sunlight to electricity by using a semiconductor, usually made of silicon [9], [10]. The word photovoltaic comes from the Greek meaning “light” (photo) and “electrical” (voltaic); the common abbreviation for photovoltaic is PV [11]. Then PV efficiency increased continuously in the following years, and costs have decreased significantly in recent decades. The main material used in the construction of PV cells is still silicon, but other materials have been developed, either for their potential for cost reduction or their potential for high efficiency [11]. Over the last 20 years the world-wide demand for PV electric power systems has grown steadily. The need for low cost electric power in isolated areas is the primary force driving the world-wide photovoltaic (PV) industry today. PV technology is simply the least-cost option for a large number of applications, such as stand-alone power systems for cottages and remote residences, remote telecommunication sites for utilities and the military, water pumping for farmers, and emergency call boxes for highways and college campuses [9]. PV cells are

converting light energy, to another form of energy, electricity. When light energy is reduced or stopped, as when the sun goes down in the evening or when a cloud passes in front of the sun, then the conversion process stops or slows down. When the sunlight returns, the conversion process immediately resumes, this conversion without any moving parts, noise, pollution, radiation or constant maintenance. These advantages are due to the special properties of semiconductor materials that make this conversion possible. PV cells do not store electricity; they just convert light to electricity when sunlight is available. To have electric power at night, a solar electric system needs some form of energy storage, usually batteries, to draw upon [12].

4.3 Principle of Photovoltaic Systems

Photovoltaic systems employ semiconductor cells, usually several square centimeters in size [13]. Semiconductors have four electrons in the outer shell, on average. These electrons are called valence electrons [11]. When the sunlight hits the photovoltaic cells, part of the energy is absorbed into the semiconductor. When that happens the energy loosens the electrons which allow them to flow freely. The flows of these electrons are a current and when you put metal on the top and bottom of the photovoltaic cells. We can draw that current to use it externally, as shown in Fig. 5.

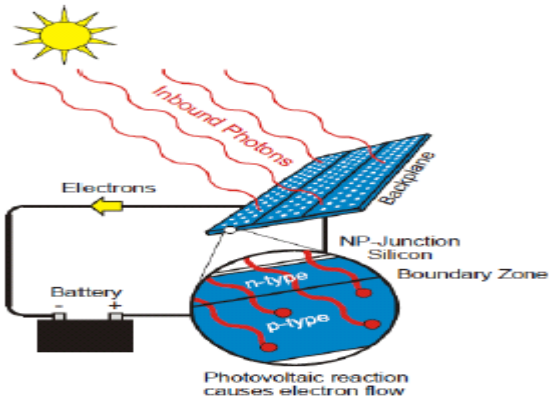


Fig. 5 Principle of Photovoltaic cells.

Many cells are collected in a module to generate required power [13]. When many such cells are connected in series and parallel combinations we get a solar PV module, the current rating of the modules depends on the area of the individual cells. For obtaining higher power output the solar PV modules are connected in series and parallel combinations forming solar PV arrays.

4.4 MPPT Algorithms

4.4.1 Review of Maximum Power Point Tracking

A set of photovoltaic cells called the solar panel. Photovoltaic cells are devices which detect electromagnetic radiation and generate a current or voltage, or both, upon absorption of radiant energy. The output power of PV arrays is mainly influenced by the irradiance (amount of solar radiation) and temperature. Moreover for a certain irradiance and temperature, the output power of the PV array is function of its terminal voltage and there is only one value for the PV's terminal voltage at which the PV panel is utilized efficiently. The procedure of searching for this voltage is called maximum power point tracking MPPT. Recently, several algorithms have been developed to achieve MPPT technique such as; Perturb and Observe (P & O), incremental conductance, open circuit voltage, short circuit current, fuzzy or neural based etc [20], [21],. However, the insulation levels and the cell temperature determine only the limits of the best obtainable matching. The array voltage determines the real matching. This mismatch can be improved by the use of a MPPT controller to locate the local maximum power point in the **p-v** response range of the solar panel [22], Fig.6 shows the P-V characteristics of a practical PV array showing MPP.

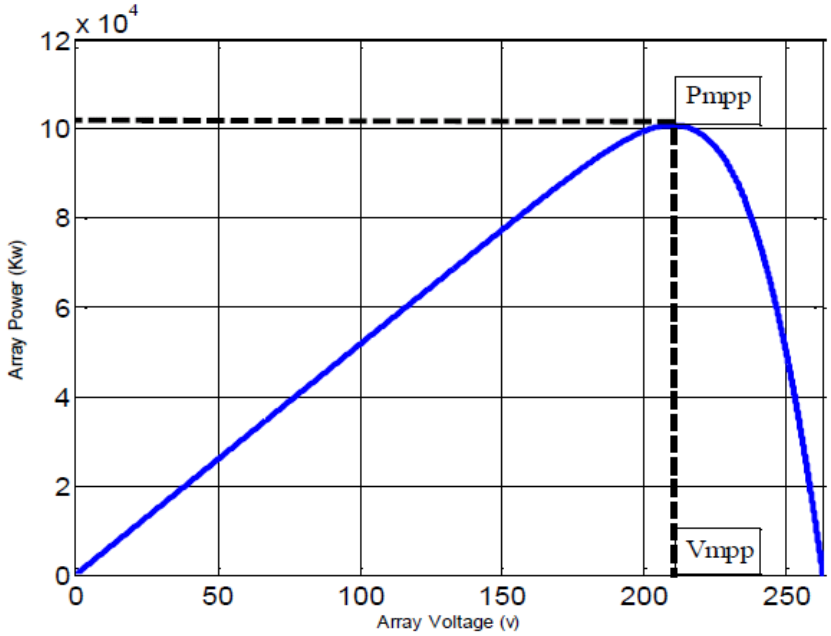


Fig. 6 P-V characteristics of a practical PV array showing MPP.

From the simulation results, the PV array under constant temperature 25oC and irradiances 1000 W/m2 for PV array. The maximum readings appear to be 210.4V, 479A and 100.8 kW.

The absolute maximum current (short circuit current) is 517A and the absolute maximum voltage (open circuit voltage) is 263V.

4.5 Maximum Power Point Tracking

A PV panel has a nonlinear characteristics and its output power depends mainly on the irradiance (amount of solar radiation) and the temperature. Moreover for the same temperature and irradiance the output power of a PV panel is function of its terminal voltage. There is only one value for the terminal voltage that corresponding to maximum output power for each particular case. The procedure of searching for this voltage is called maximum power point tracking. Maximum power point tracking of a PV panel can be obtained either in a single stage or in a double stage. In the case of single stage, a DC/AC converter is utilized. On the other hand in case of double stage a DC/DC and DC/AC converters are utilized. The characteristics of PV shown in Fig. 6shows that the maximum power point for this particular panel lays at the values between approximately 75-80% of array's open circuit voltage. Consequently, in this thesis the maximum power point tracking algorithm scans the P-V curve at predefined voltage of 75% from the array‟s open circuit voltage. The MPPT techniques are accomplished through the DC/DC converter which interfacing the PV array to the inverter [23]. This can be achieved by controlling the input voltage of the DC/DC converter. Fig. 7 shows the Maximum power point tracker (MPPT) system as a block diagram.

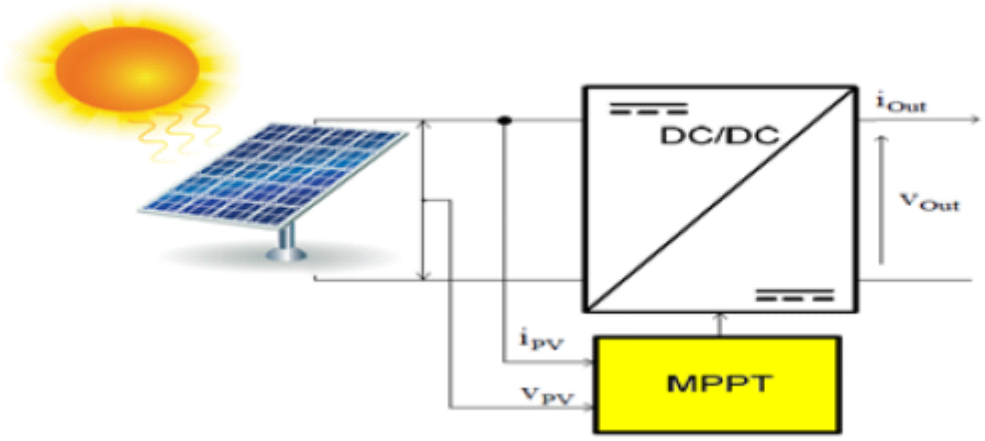


Fig. 7 Maximum Power Point Tracker (MPPT) system as a block diagram.

Maximum power point tracker (MPPT) tracks the new modified maximum power point in its corresponding curve whenever temperature and/or in solation variation occurs. MPPT is used for extracting the maximum power from the solar PV array and transferring that power to the grid. A DC/DC (step up/step down) converter acts as an interface between the inverter and

the array. The MPPT changing the duty cycle to keep the transfer power from the solar PV array to the grid at maximum point [22], [23]. The function of the inverter is to convert the output DC voltage of the PV into AC and to keep the output voltage of the DC/DC converter constant. In order to accomplish that, two controllers are required; one for the DC/DC converter, and the other for the inverter.

4.6 Control Algorithms

There are two algorithms which are used in this thesis for MPPT [24], [25]:

- Hill Climbing methods
- Fuzzy Based Algorithm

4.6.1 Hill Climbing Method

The hill climbing based techniques are so named because of the shape of the power-voltage (P-V) curve. This technique is sub-categorized in two types:

- Perturb & Observe Algorithm (P & O)
- Incremental Conductance Algorithm (ICT)

4.7 Boost Converter and Inverter

4.7.1 Introduction

This chapter deals with the operation of boost converter and the operation of inverter. The boost converter makes the output voltage of the converter to be greater than that of input which is required for the operation of inverter. The boost converter uses the maximum power point algorithm for getting triggering signal. The inverter converts the available dc input power into ac power at its output. This chapter explains the operation of boost converter and the inverter in its on and off modes. The theoretical diagrams for the operation are also given at the end for the analysis purpose.

4.7.1.1 Boost Converter

DC-DC converters have huge applications in telecommunication, digital applications, software industry, and in the industrial applications. The output voltage after applying these converters maybe high or low or equal to the supply depending on the type of the converters used. For the boost converters the output voltage is greater than the input voltage which is required for the special type of applications. The basic boost converter consists of an inductor (Ls), power electronic switch, unidirectional diode, capacitor (Cl). The Duty cycle to the

power electronic circuit can be varied using some specially designed firing circuit. Here we will give the firing to the converter using maximum power point tracking technique, which will drive the converter at its maximum power point operation.

4.7.1.2 Operation of the Boost Converter

The electrical circuit of the boost converter is shown in the figure. The dc supply is connected to the inductor (Ls). When the power electronic switch is fired using the gating signal then the source is short circuited through the inductor. The stores the energy during the turn on process of the converter. In this turn on time capacitor at the load side feeds the load. When the power electronics witch is turn off then the load is connected through the source and the inductor. The load is feed through the source and the inductor, makes the load voltage greater than the source voltage. The output voltage is in phase with the input voltage. The output voltage completely depends upon the duty ratio of the converter. If the duty ratio increases then the output voltage increases, if the duty ratio decreases then the output voltage increases. When the power electronic switch is turned on then the current in the inductor increases. The slope with which the inductor current increases is given by

$$\frac{dIs}{dt} = \frac{Vs}{Ls}$$

In this situation the capacitor voltage is equal to the load voltage. The capacitor supplies the load current. The capacitor voltage is always greater the supply voltage. When the switch is opened the inductor current decreases. The voltage across the inductor is equal to (Vl-Vs).

4.7.1.3 Boost Converter Circuit

The boost converter circuit is shown in the figure, consists of dc source for supplying the power to the converter, inductor for storing energy in the form of magnetic field, Power electronic converter for the purpose of switching operation, unidirectional diode for separating source and load circuit, Capacitor for the purpose of continuous current operation, and load.

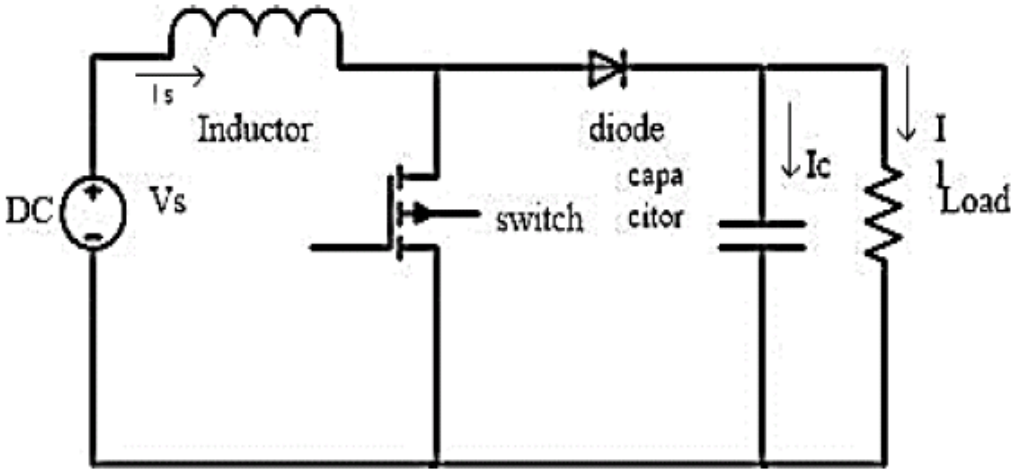


Fig. 8 Boost converter circuit.

4.7.1.4 Boost Converter During ON Time

During the on time inductor is connected in parallel to the source. The voltage of the supply is equal to the voltage of the inductor. So as to maintain the voltage as constant the current will be steeply increasing in nature with slope of (Vs/Ls). The capacitor connected across the load. So as to maintain the load current as constant the capacitor supplies the load current required for the continuous operation. The equavalant circuit of the boost converter during the on state is given in the fallowing figure.

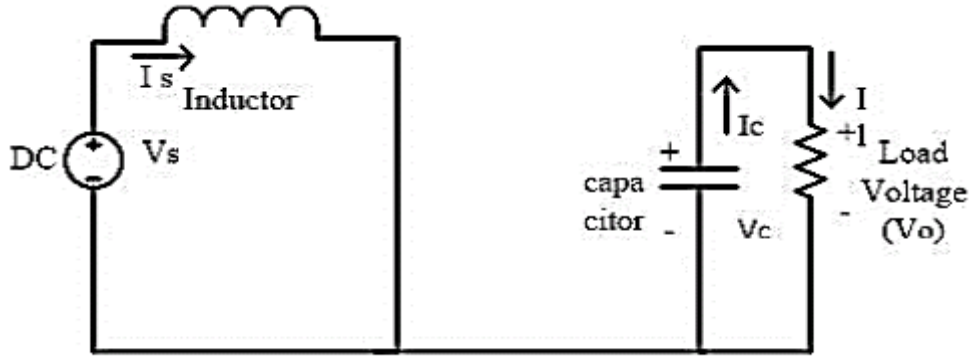


Fig. 9 Equivalent circuit of boost converter during on time

5 REACTIVE POWER COMPENSATION THEORY

5.1 Introduction

The operation of reactive power compensation theory. The harmonics present at the load side are mainly due to nonlinear loads present at the output side. The nonlinear loads involves the converters and inverters at the output side of the grid connected system. The reactive power

compensation theory is one of the methods for the elimination of harmonics present at the output side of the grid. By controlling the triggering of the inverter switches for making the current to be in phase with the voltage.

For voltage stability, the second generation fact device are used which compensates and balance the power flow in multiline. The interline power flow controller (IPFC) is also used for controlling the active and reactive power in lines. The interline power flow controller consist a voltage source converter based two facts controller for series compensation. The reactive voltage injected by individual voltage source converter can be controlled to regulate the active power flow in the lines. In this system 4-Bus system is present. The open and closed loop model is also developed and used for simulation [4]. The IPFC is connected through the series coupling transformer and comparison of active and reactive power of transmission line with and without IPFC is presented using the proposed circuit model. In this model SSSC is used .One on each line of two lines. MATLAB with simulink and SIM POWER SYSTEM tools are used for simulation of transmission line and results are compared. The IPFC is open loop and closed loop configuration is also described [5]. The interline power flow controller is basically a voltage source converter based flexible ac transmission system controller for series compensation with unique capability of power flow management among the multiline transmission system of a substation. In this system, for voltage stability, the second generation fact device are used which compensates and balance the power flow in multiline. The interline power flow controller (IPFC) is used for controlling the power flow in lines. The interline power flow controller consist a voltage source converter based facts controller for series compensation. The reactive voltage injected by individual voltage source converter can be controlled to regulate the active power flow in the line. In this system 4-Bus system is present. The open and closed loop model is developed and used for simulation of system [4]. III. POWER QUALITY ISSUES The power quality of system is effected due to the harmonic generation, voltage sag, voltage swell, and Over current and flickering. To improve the power quality of system, firstly reduce these parameters. The main factor which affects the power quality is given below.

1. Voltage sags
2. Voltage swells
3. Inrush
4. Transient
5. Over current
6. Flickering

This is very difficult to identify the whether the cause of power quality is consumers side or suppliers side. The power quality is common problem for suppliers and user's system. The power disturbance can be classified into the following categories

A. Power outage

The total interruption of supply is called a power outage. The power outage is an accrue problem is due to the ice storms: lightning: wind: utility equipment failure. The effect is complete interruption in the supply system.

B. Voltage fluctuation

Every piece of equipment is particular range of input voltage. When the voltage is above or lowers than this voltage. Then this is called a voltage fluctuation. The voltage fluctuation is accruing due to the sudden changes in the load and when the large equipment is on and off. The effects of voltage fluctuation is light is flicker and equipment is shut down. The motor will also stopping.

C. Transients

The transients are also called surges. This type of disturbance is accruing for very short time. The equipment down the line because when transients accrue many voltages can be generated into the electrical system. The main causes of transients are suddenly starting or shut down the equipment. Example is welding equipment. The main effect of transients is burned circuit boards and the equipment is damage.

D. Harmonics

Harmonics are the distortion of the sine wave. The harmonics are accruing due to the non linear loads. The effects of harmonic is overheating of equipment and neutral is also hot.

5.2 Reactive Power Compensating (RPC) Scheme

The load draws current of non-sinusoidal in nature. The current wave form at the grid effected by the load connected to it. The photovoltaic output converted into ac power and supply it to the grid. Besides to this property the harmonic current presented in the load can be controlled using proper controlling of the inverter current. If the harmonic current presented in the load is compensated by the solar cell current then the harmonics will be freed

from the circuit. The actual thing that is happening here is the compensation of the reactive power taken by the load, with that of there active power generated by the solar cell.

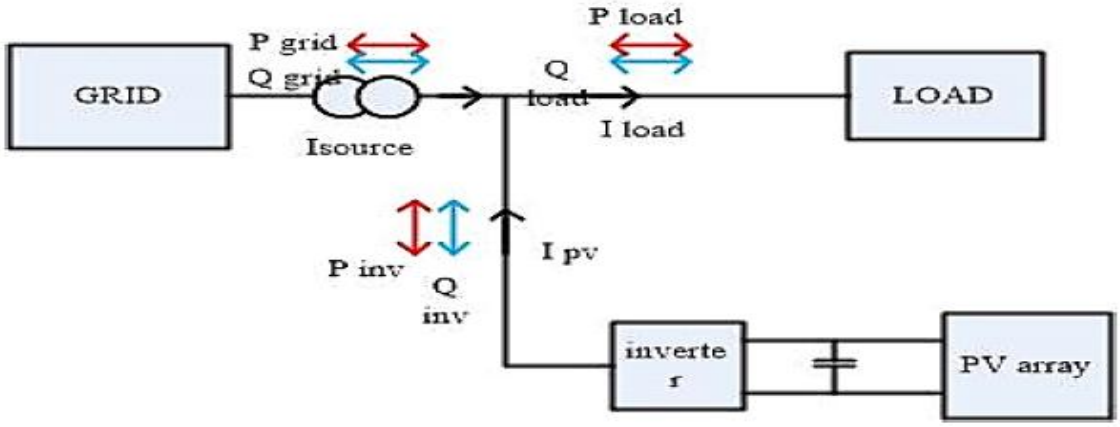


Fig. 10 Block diagram view of the reactive power compensation system

In the reactive power compensation theory the actual currents in system are converted into α-β frame of reference. From this frame of reference the reactive power of the system is calculated. The reactive power of the inverter and the active power of the solar cell are obtained. Using these two values reference values for the currents in the α-β frame of reference are calculated. From α-β reference values the reference currents in the abc frame of reference will be obtained. From the reference value is given as the input to the hysteresis controller. The hysterics controller compares the actual value of the with inverter current. It produces the pulses required maintaining the current to be in phase with voltage. And the current consists of pure sinusoidal. There by this method suits better for the rectification of harmonics.

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